Very high luminosity: intro

CB

LHCb Italia

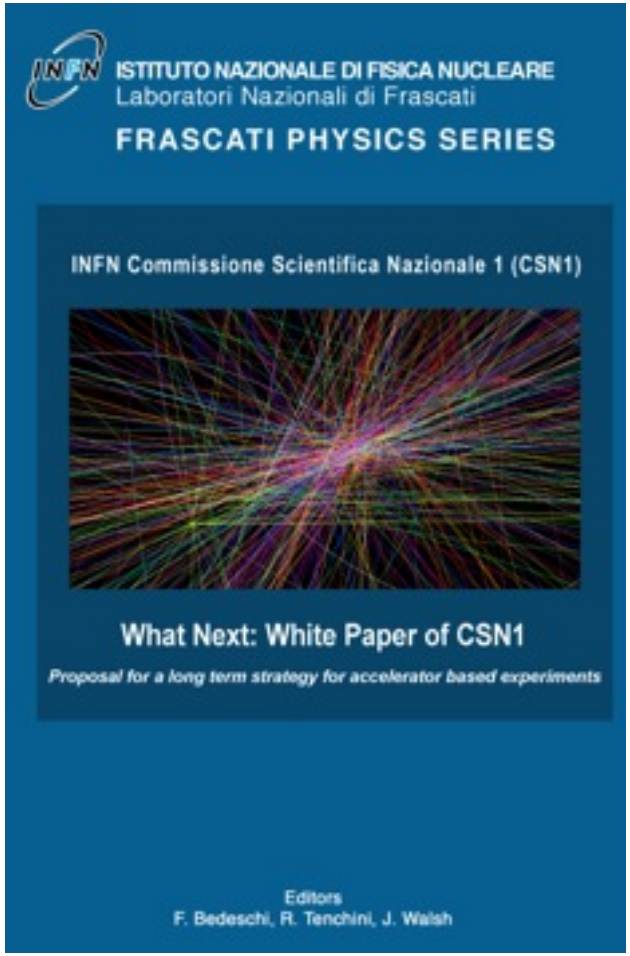
LNF, October 13th 2015

European Strategy for Particle Physics

Europe's top priority should be the exploitation of the full potential of the LHC, including the high-luminosity upgrade of the machine and detectors with a view to collecting ten times more data than in the initial design, by around 2030. This upgrade programme will also provide further exciting opportunities for the study of flavour physics and the quark-gluon plasma.

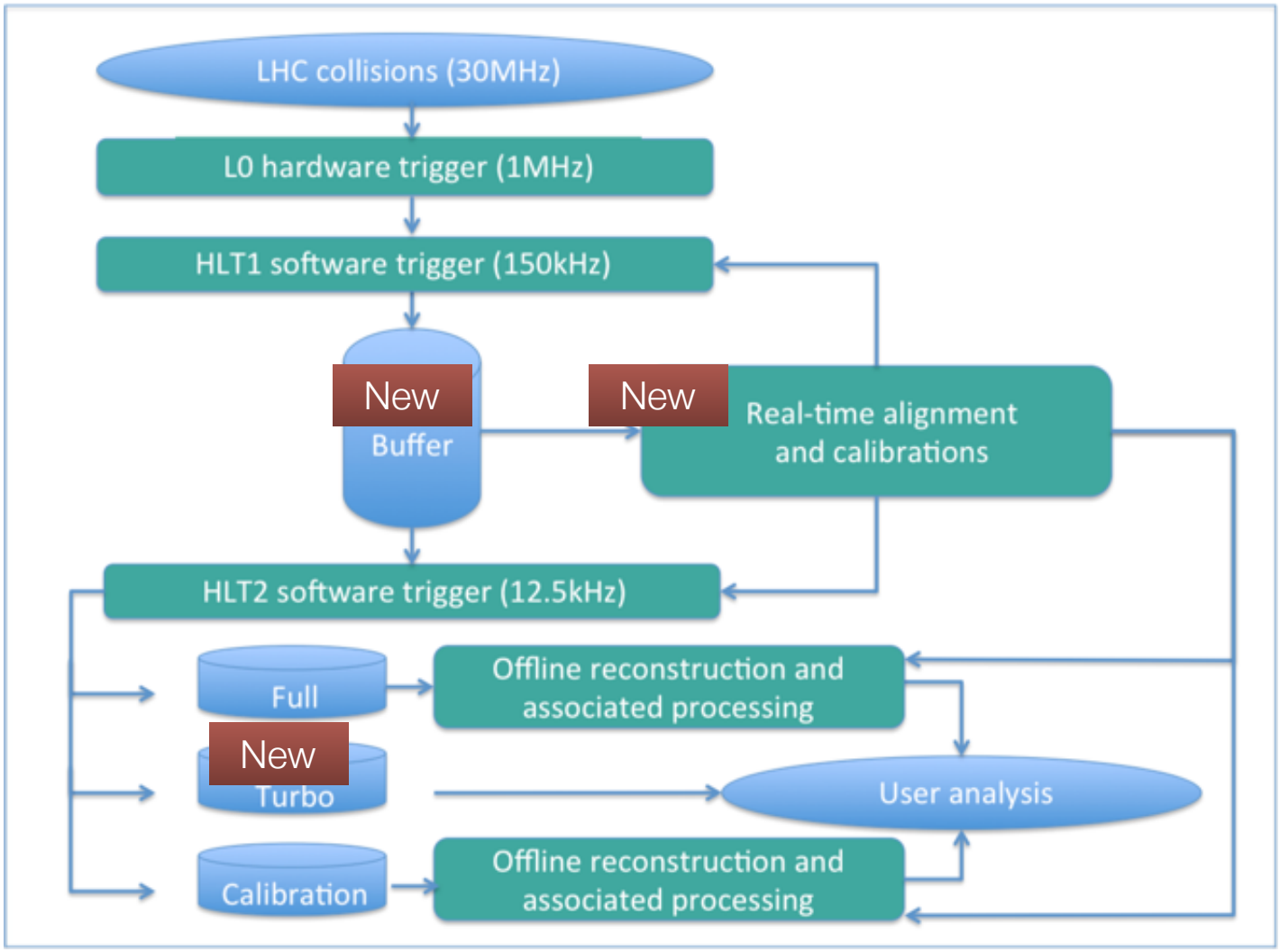
European Strategy Update

CSN1 White paper, flavour summary

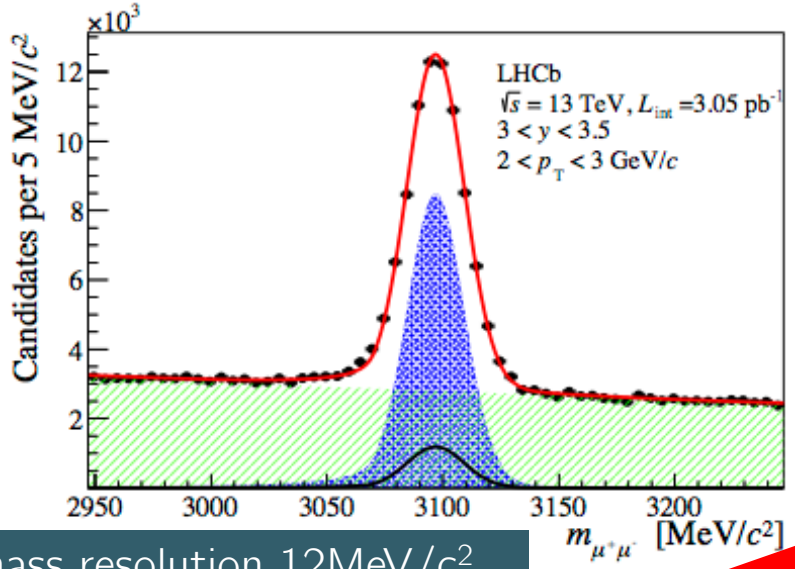


an extreme flavour experiment In order to push to the extreme the intensity frontier, the very interesting possibility of exploiting the full luminosity provided by the HL-LHC (or by any future hadron collider) for flavour physics has been considered. This poses severe experimental and theoretical challenges: can a sample of 10^{14} bottom and 10^{15} charm mesons be fully exploited? Can theoretical uncertainties be kept below the projected experimental ones for a large number of interesting observables? While a full answer to these questions requires a much more detailed study than what was possibly achievable in the What Next WG, at present the necessary technical developments do not seem unfeasible. From the experimental point of view, storing and processing such data samples is a huge technological challenge, even if projected a decade into the future, thus requiring a paradigm shift by which data analysis will be performed in real time, rather than off-line. A detector with strong tracking capability at high luminosity seems technologically within reach, while a readout at 40MHz will be doable thanks to the foreseen progress of telecom technology. Specialized processors are needed to perform real-time event reconstruction and get tracks and other complex primitives straight out of the detector. The expected progress in CPU processing power would allow offline-grade reconstruction and calibration in real-time. Physics analysis *in real time* requires the ability to do precision measurements from reduced-size stored samples, the need to overcome the *event* concept by saving statistical summaries only, the usage of well-chosen control samples and special methods to control systematic effects. The resulting physics potential is impressive, leading to a determination of the angles of the unitarity triangle at the 0.1° level and of the CKM parameters at the 0.1% level, corresponding for example to a theoretical uncertainty on $BR(B_d \to \mu^+\mu^-)/BR(B_s \to \mu^+\mu^-)$ below 2%, to be compared with the expected experimental uncertainty of $\sim 4\%$; CP violation in charm mixing will be probed at the 0.1° level, comparable to the expected SM uncertainty. These are just a few examples of an extremely rich physics program that is still under investigation.

LHCb Run2


LHC collisions (30MHz)
L0 hardware trigger (1MHz)
HLT1 software trigger (150kHz)
New
Buffer
New
Real-time alignment and calibrations
HLT2 software trigger (12.5kHz)
Full
Offline reconstruction and associated processing
New
Turbo
User analysis
Calibration
Offline reconstruction and associated processing

Turbo stream: J/ψ production at 13 TeV



mass resolution 12MeV/c^2
consistent with Run 1 offline

arXiv:1509.00771

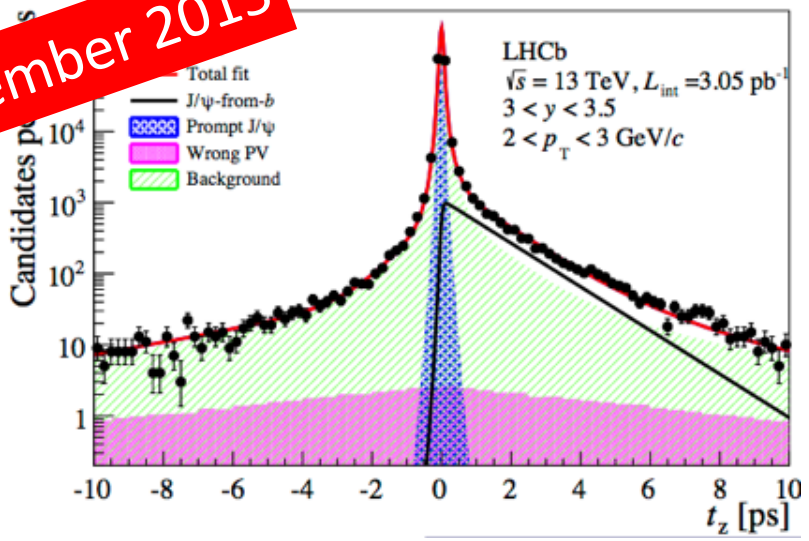
Analysis finds ~10^6 candidates directly from the trigger.

No further reconstruction, all necessary information is persisted from the trigger

S. Benson, LHCC september 2015

Component[illegible] B decays found from t_z distribution

$$t_z = \frac{(z_{J/\psi} - z_{PV})M_{J/\psi}}{p_z}$$



Turbo stream: charm production at 13 TeV

- Analysis uses 5pb^{-1} collected in July.
- Minimum bias trigger at L0 combined with Turbo Hlt2.
- $D^0 \to K^-\pi^+$, $D^+ \to K^-\pi^+\pi^+$, $D_s^+ \to \varphi\pi^+$ and $D^{*+} \to D^0\pi^+$ used to measure cross-sections.
- Integrated cross-section a… determined in fiducial…

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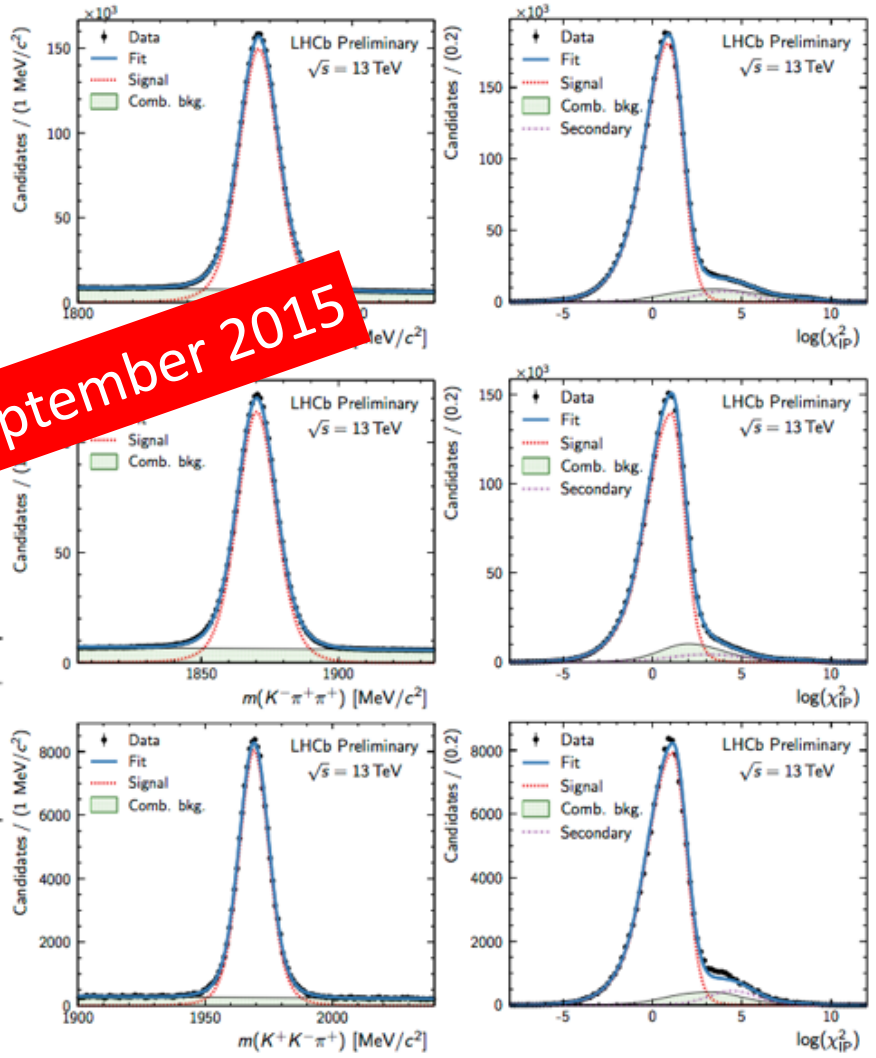
			Extrapolation factor	Cross-section (μb)
D^0	$0 < p_T < 8\,\text{GeV}$	$2 < y < 4.5$	1.0005 ± 0.0009	$2920 \pm 3 \pm 158 \pm 166$
D^+	$0 < p_T < 8\,\text{GeV}$	$2 < y < 4.5$	1.058 ± 0.033	$2516 \pm 11 \pm 228 \pm 213$
D_s^+	$1 < p_T < 8\,\text{GeV}$	$2 < y < 4.5$	-	$2490 \pm 31 \pm 265 \pm 700$
D^{*+}	$1 < p_T < 8\,\text{GeV}$	$2 < y < 4.5$	1.0004 ± 0.0023	$1897 \pm 13 \pm 187 \pm 254$

- $c\bar{c}$ cross-section measured to be 2.72±0.01±0.18±0.14mb



Think-Tank for Future Upgrades (TTFU)

[V. Vagnoni, PPG June 18th 2015]

- The LHCb management has started since some time an effort to think of possible future upgrades
- TTFU is a discussion group that reports to the Upgrade Planning Group (UPG) and currently consists of
  - Pierluigi Campana, Monica Pepe Altarelli, Giovanni Punzi, Sheldon Stone, Frederic Teubert, Vincenzo Vagnoni, Guy Wilkinson
- This group has met several times and convened two open meetings (on 17/02/15 and 21/04/15)
- Healthy and necessary to start discussing next-step Upgrade(s)
- Existing Upgrade activities are now sufficiently robust not to be vulnerable to these discussions

Open TTFU (Think Tank for Future Upgrades) meeting

Tuesday, 17 February 2015 from 14:20 to 18:00 (Europe/Zurich)

CERN (40-S2-D01 - Salle Dirac)

Description For Vidyo please use Tuesday meeting

Tuesday, 17 February 2015

14:20 - 14:40 Introduction *20'*
Speaker: Guy Wilkinson (University of Oxford (GB))
Slides

14:45 - 15:05 Physics motivation I *20'*
Speaker: Vincenzo Vagnoni (Universita e INFN, Bologna (IT))
Slides

15:10 - 15:30 Physics motivaton II *20'*
Speaker: Frederic Teubert (CERN)
Slides

15:35 - 15:55 Technological possibilities for a super-VELO *20'*
Speaker: Paula Collins (CERN)
Slides

16:00 - 16:30 Coffee

16:30 - 16:50 High luminosity running with a (more) displaced IP *20'*
Speaker: Pierluigi Campana (CERN-LNF)
Slides

16:55 - 17:15 Calorimetry ideas *20'*
Speaker: Sheldon Stone (Syracuse University (US))
Slides

17:20 - 17:30 First thoughts about a RICH at very high lumi *10'*
Speaker: Carmelo D'Ambrosio (CERN)
Slides

17:35 - 17:45 TORCH: status update *10'*
Speaker: Roger Forty (CERN)
Slides

Open TTFU (Think Tank for Future Upgrades) meeting

Tuesday, 21 April 2015 from 13:30 to 18:00 (Europe/Zurich)

CERN (13-2-006)

Description Agenda available under 59th Analysis and Software Week: https://indico.cern.ch/event/331664/

Think Tank For Future Upgrades

Conveners: Guy Wilkinson (University of Oxford (GB)), Monica Pepe-Altarelli (CERN)

13:30 **Introduction** *10'*
Speaker: Guy Wilkinson (University of Oxford (GB))
Slides

13:45 **Tracking at very high intensity** *25'*
Speakers: Giovanni Punzi (Universita di Pisa & INFN (IT)), Giovanni Punzi (FNAL), Giovanni Punzi (Pisa University and INFN)
Slides

14:15 **Challenges for SciFi at high lumi** *20'*
Speaker: Ulrich Uwer (Ruprecht-Karls-Universitaet Heidelberg (DE))
Slides

14:40 **Machine perspective on high lumi operation at IPB** *25'*
Speaker: Dr. Helmut Burkhardt (CERN)
Slides

15:10 **Update on displaced vertex option** *25'*
Speaker: Pierluigi Campana (Frascati)
Slides

15:40 Coffee *30'*

16:10 **Challenges of operating muons at high lumi** *20'*
Speaker: Dr. Alessandro Cardini (INFN Cagliari, Italy)
Slides

16:35 **Requirements on timing for PV association at high lumi** *25'*
Speaker: Vladimir Gligorov (CERN)
Slides

17:05 $h \to c\bar{c}$ **perspectives** *25'*
Speaker: J Michael Williams (Massachusetts Inst. of Technology (US))
Slides

Next talks

- Vincenzo: physics case
- Pierluigi: detector aspects
- Giovanni Pu: trigger, DAQ and offline